

# Predicting Growing Season Grassland Production in the Spring using Sea Surface Temperatures, NDVI, and Grass-Cast

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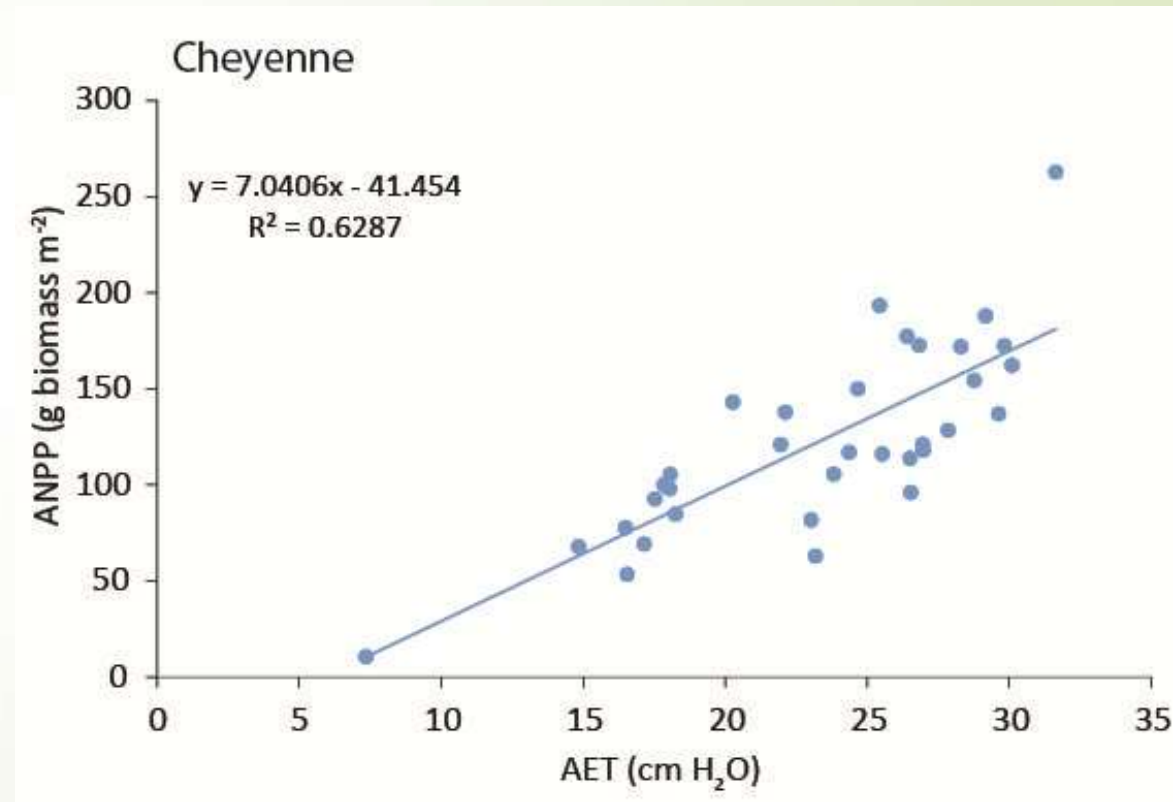
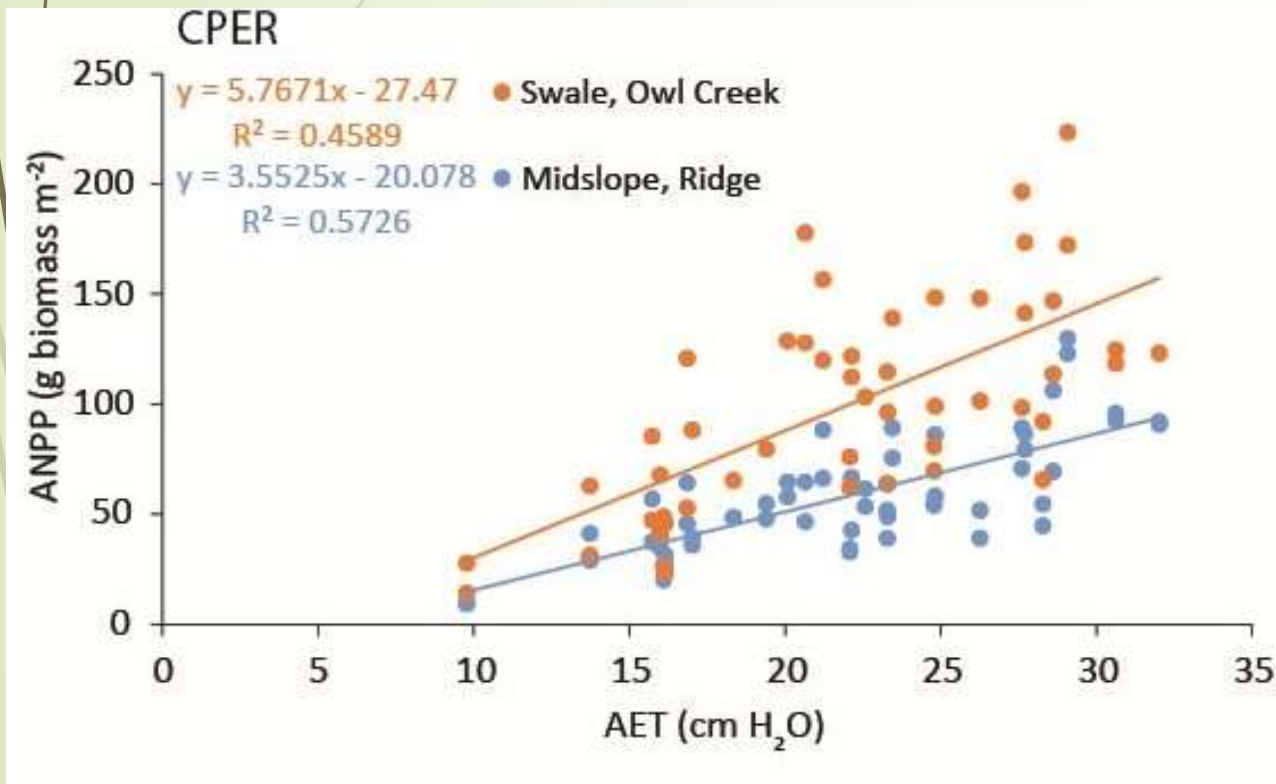
# Outline

- Correlation of annual aboveground plant production (ANPP) to Rainfall Variables and AVHRR NDVI data (1982 to 2014)
  - Long term annual ANPP data from Cheyenne (1940 to 2014)
  - Site-level AVHRR NDVI and ANPP
  - Regional Great Plains simulated AET using the DayCent ecosystem model
- Using Grass-Cast to simulate seasonal forecast of ANPP for the Great Plains
- Conclusions

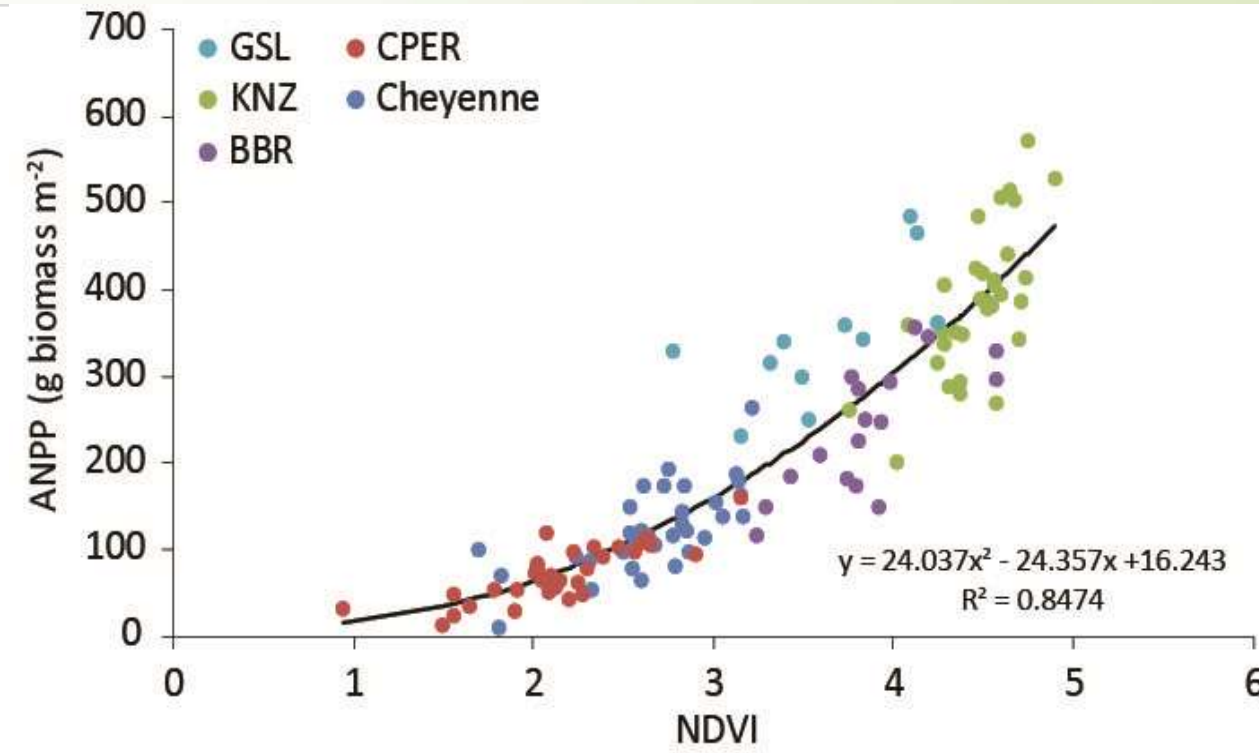
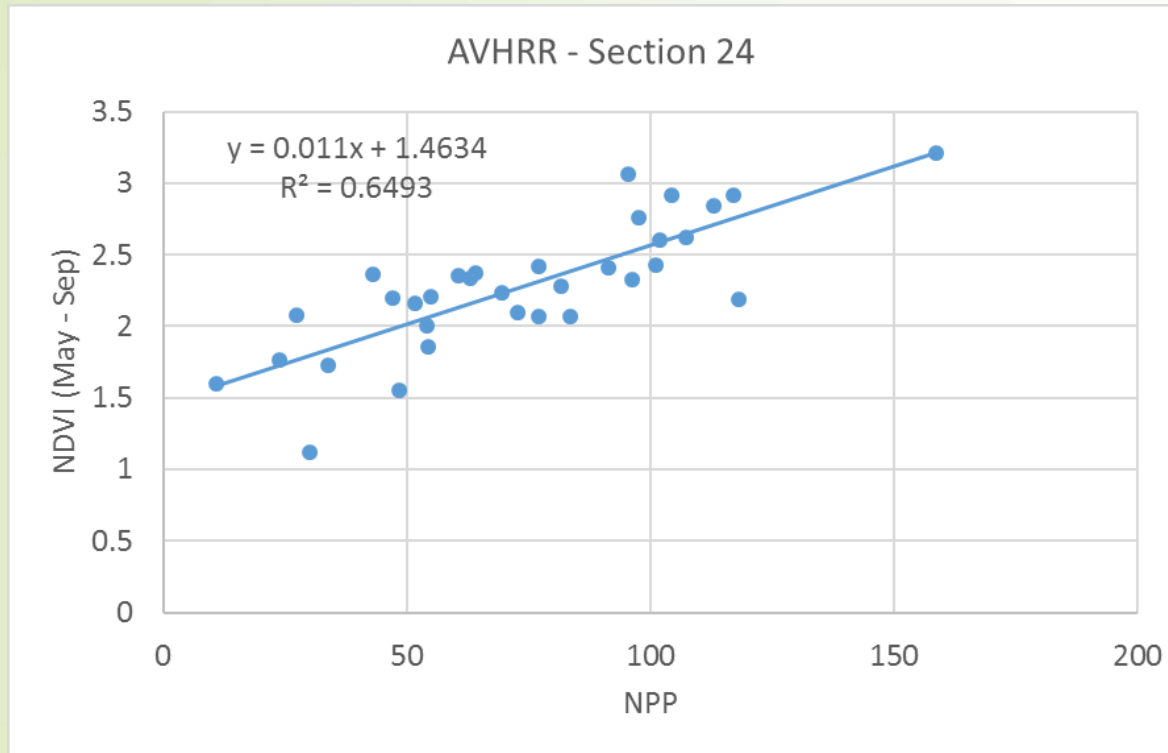
# Cheyenne Correlation of ANPP to Rainfall Variables

Site		Apr – May	Apr – Jun	Apr – Jul	Apr – Aug	Apr – Sep	Annual
Cheyenne	Precipitation	0.4053	0.5685	0.5966	0.361	0.2003	0.2111
	Transpiration	0.0648	0.3428	0.5838	0.4882	0.4612	0.4609
	AET	0.2275	0.4527	0.6478	0.5152	0.4711	0.4082

# Correlation of April to July Cumulative Actual Evapotranspiration (iAET) to Grassland Plant production (ANPP)

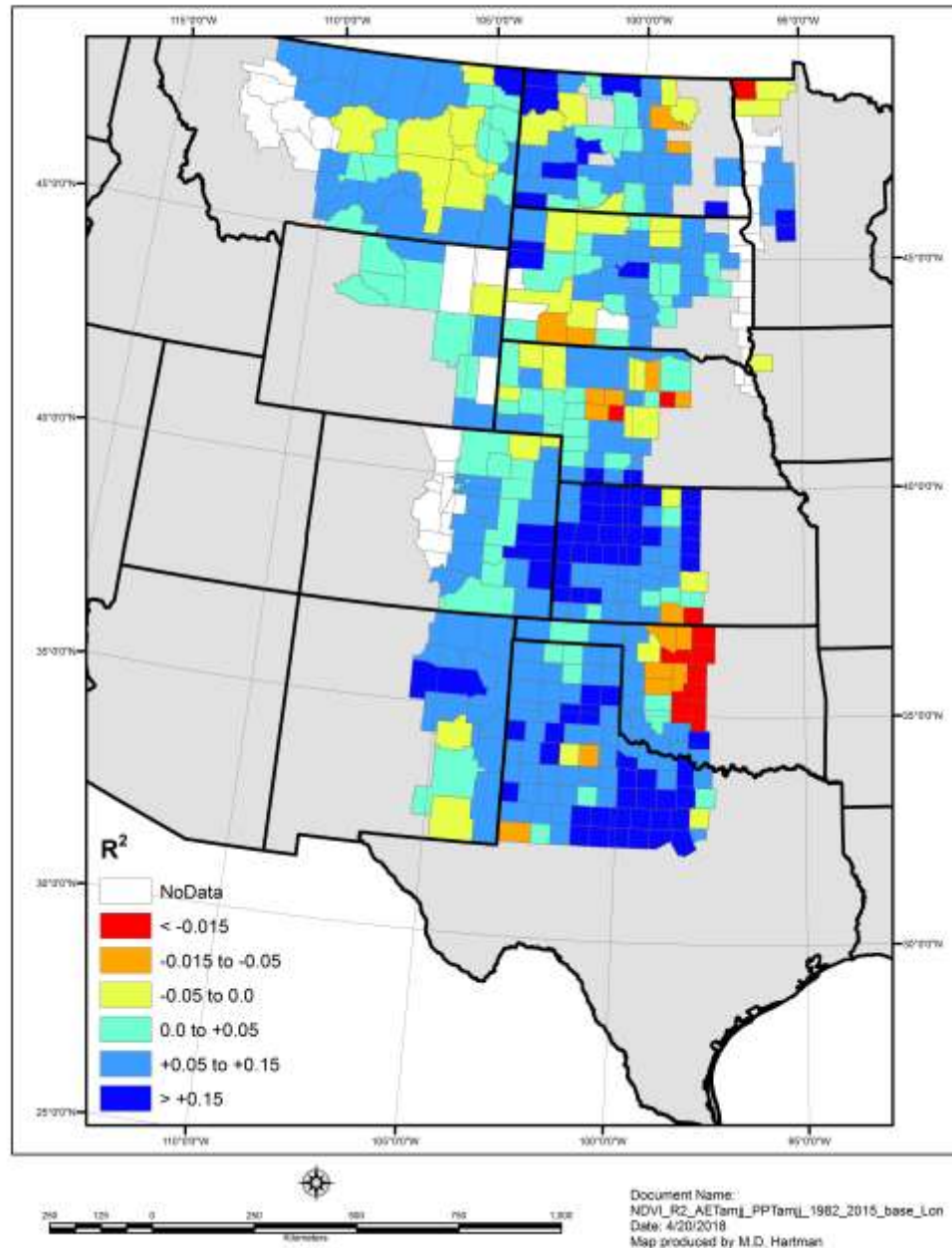


# Site-level AVHRR NDVI vs. ANPP (1982-2016)



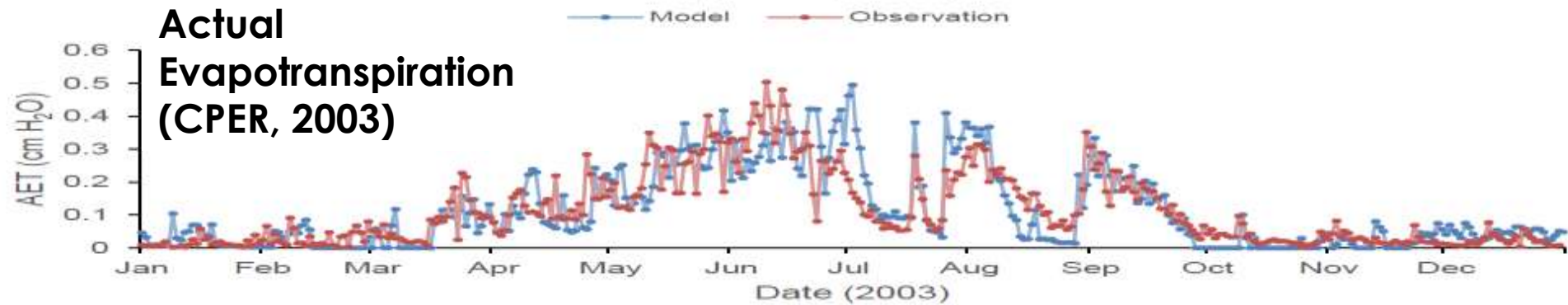


Difference  $R^2$  AETamjj and PPTamjj to NDVIimjjas 1982-2015

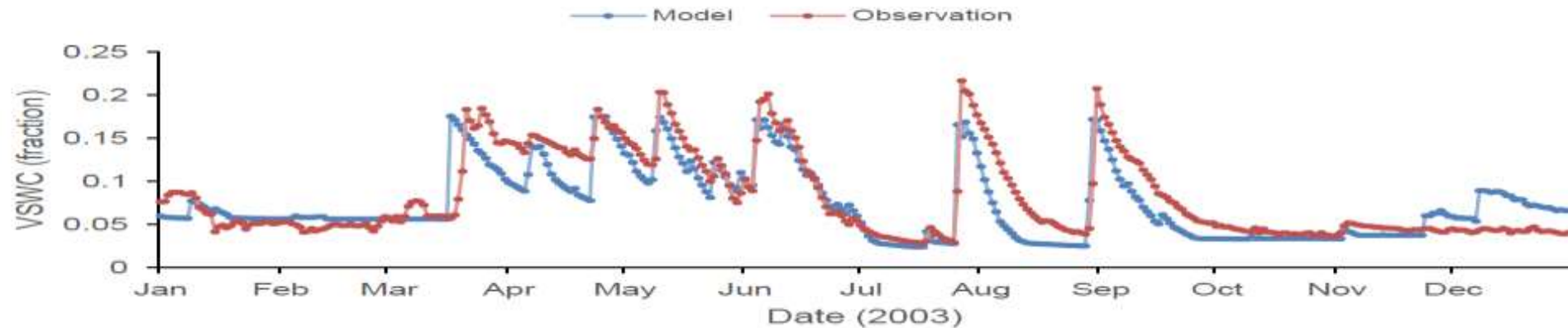


Difference in  $R^2$   
when AET (April-July) is correlated to  
cumulative (May-September) NDVI  
vs  
when Precipitation (April-July) is  
correlated to cumulative NDVI

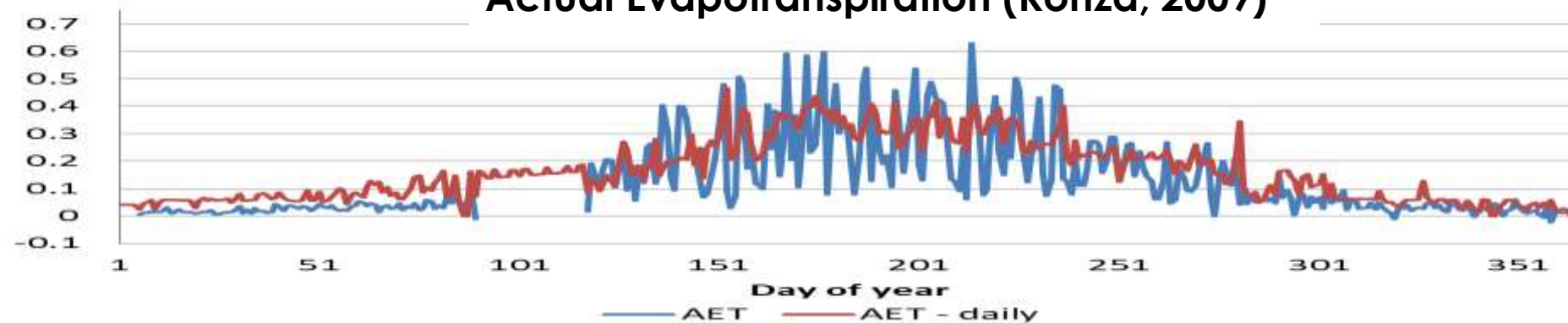
### Actual Evapotranspiration (CPER, 2003)



### Volumetric Soil Water Content (CPER, 2003)



### Actual Evapotranspiration (Konza, 2009)






# Grass-Cast Project Goals

- Predict total growing season above-ground grassland plant production (ANPP) for all Great Plains counties in the Spring as function of the April to July cumulative actual evapotranspiration water loss (iAET)
  - Starting in April, update ANPP forecasts every two weeks based on current weather data and new precipitation forecasts (monthly basis).
- 





# Key Assumptions

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1. Annual above-ground grassland plant production (ANPP) is correlated to cumulative April to July actual evapotranspiration water loss (iAET).
  2. ANPP is correlated to cumulative growing season (April to October) remote sensing NDVI (iNDVI).
  3. The DayCent grassland ecosystem model can simulate AET as a function of observed daily weather data and predicted precipitation

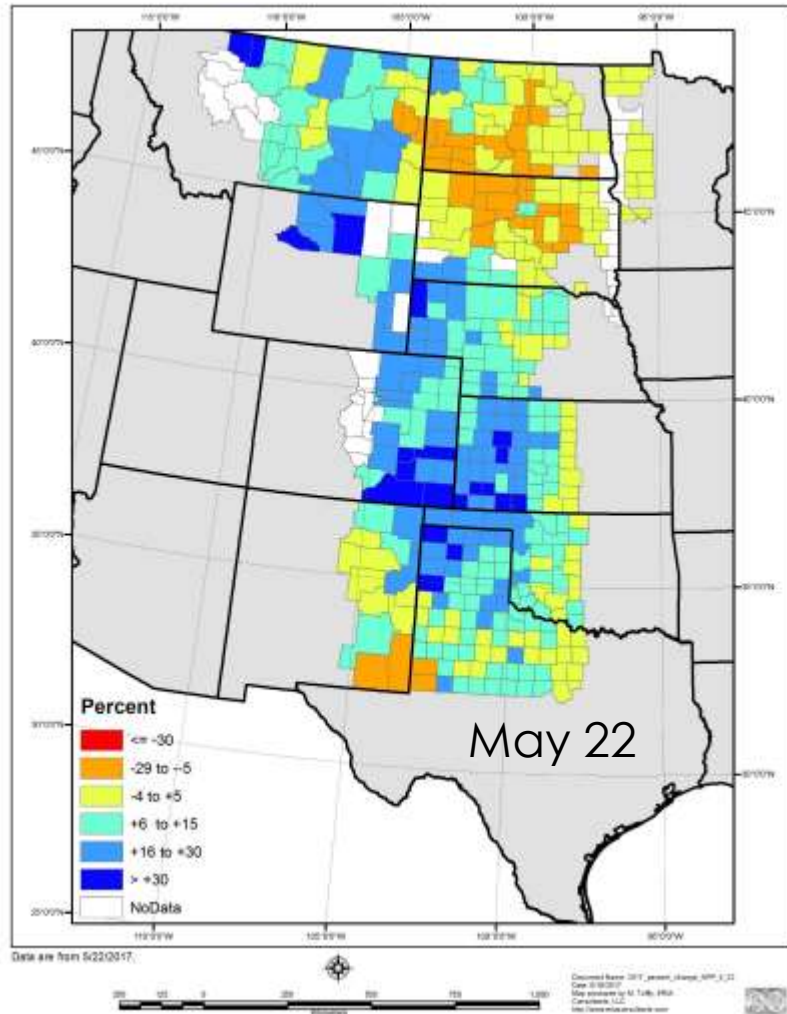
# Forecast Procedure

1. Use DayCent model to simulate 2017 county-level iAET (7 to 10 model runs per county) based on observed weather data and CPC precipitation forecast.
2. For each model run, make prediction of growing season cumulative NDVI (iNDVI) based on county-level correlation of iAET to iNDVI .
3. For each iNDVI prediction, use the Great Plains correlation of iNDVI to ANPP to predict annual ANPP for each county.
4. The mean predicted annual ANPP for 2017 is the mean of 7 to 10 ANPP predictions.

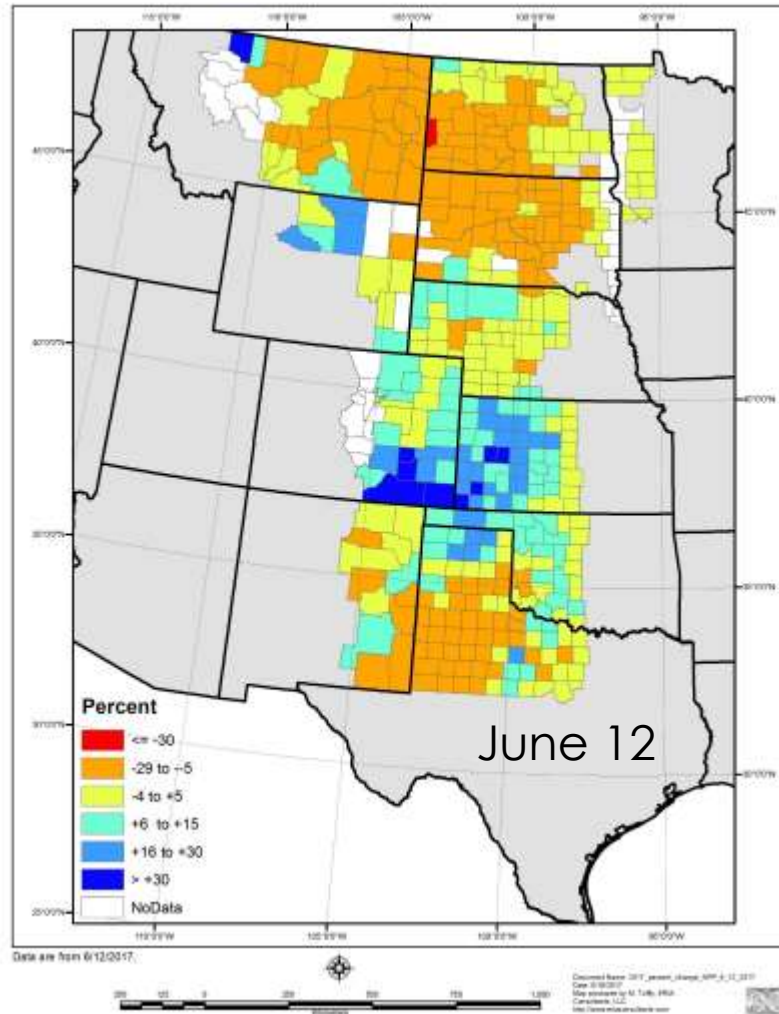
# Grass-Cast Growing Season ANPP Forecasts

(Percent change compared to 30-yr mean predicted ANPP)

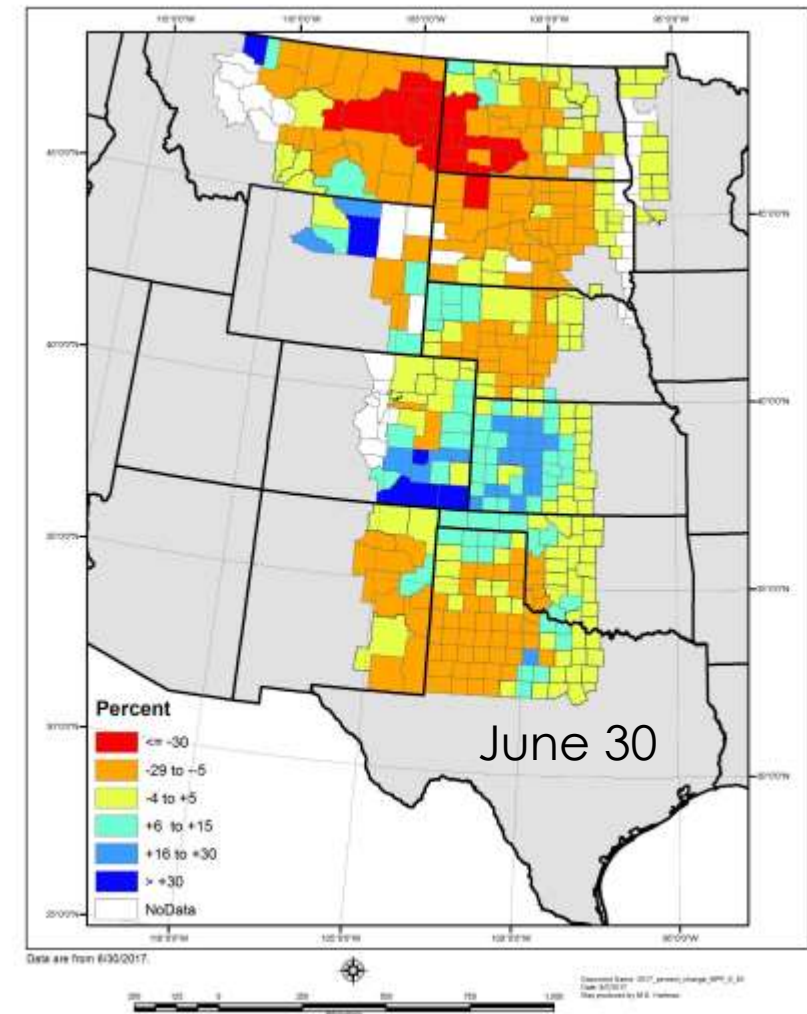
Percent Change in 2017 Predicted NPP compared to 1986 - 2016 mean NPP (%)



Percent Change in 2017 Predicted NPP compared to 1986 - 2016 mean NPP (%)

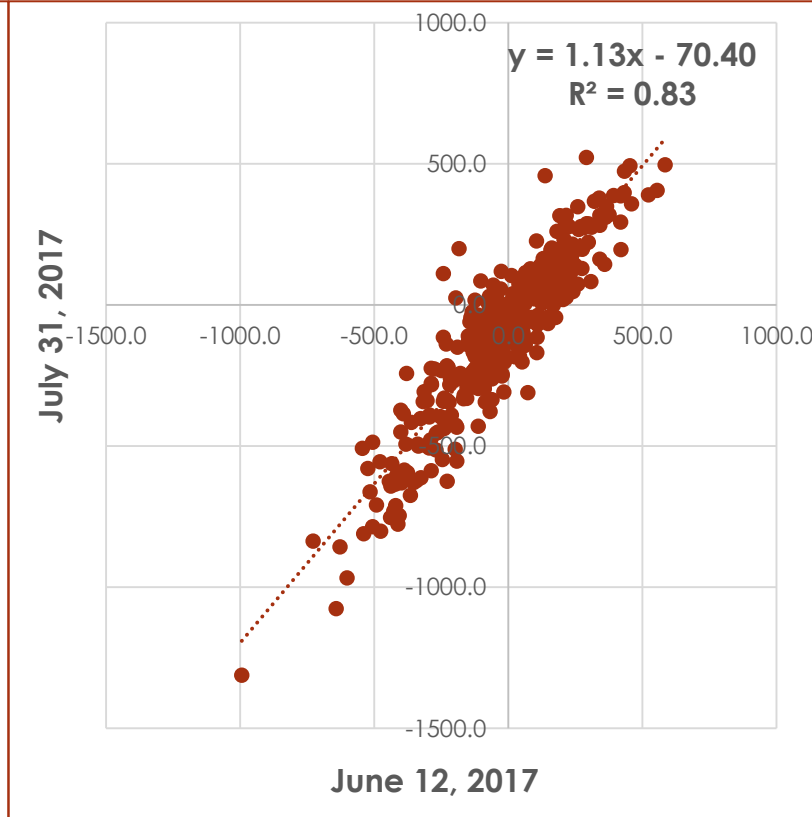
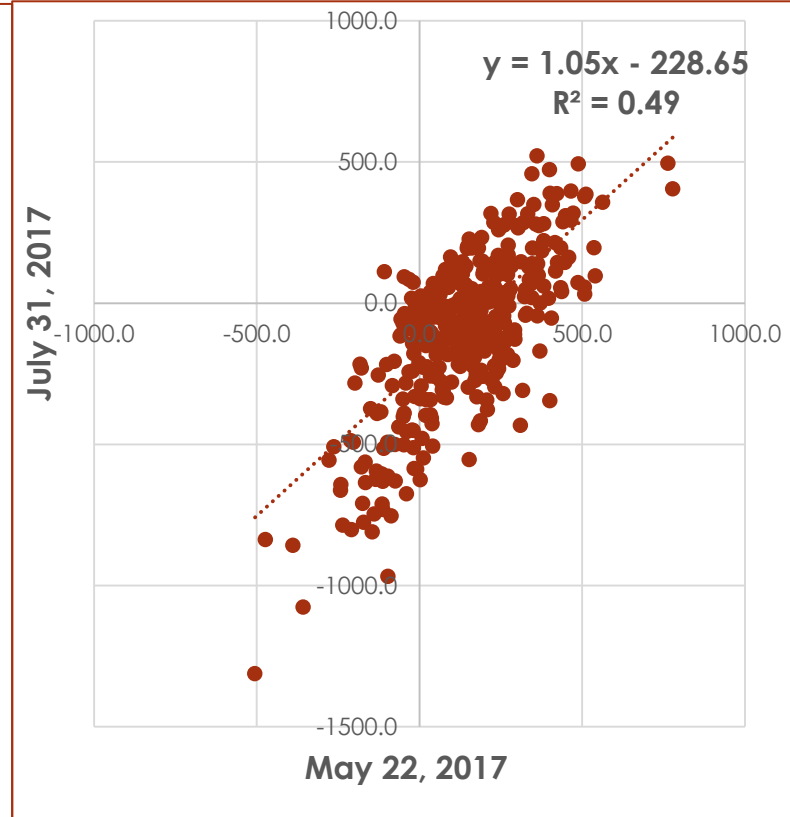
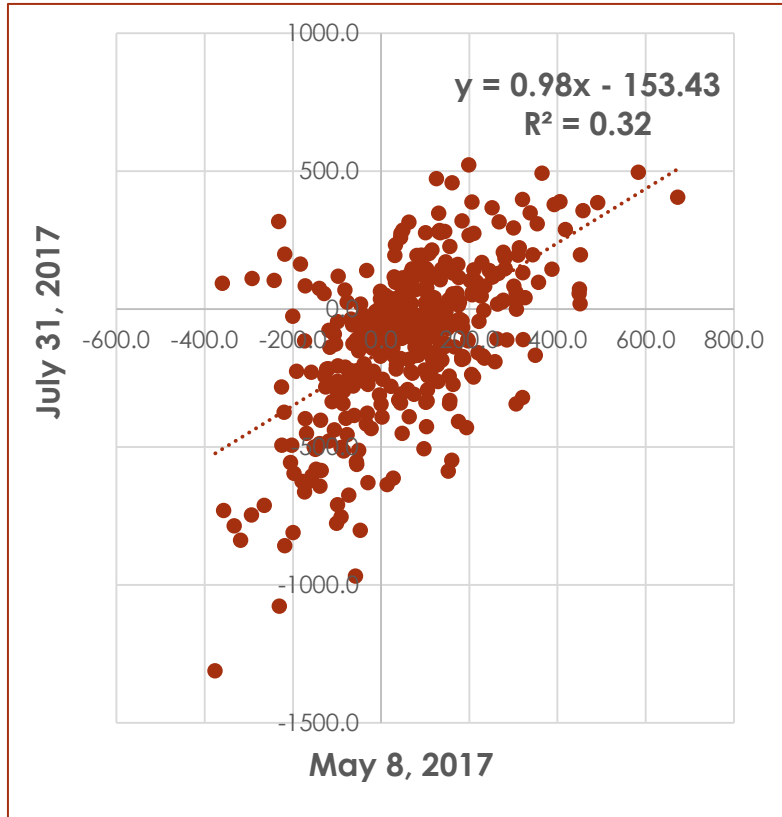


Percent Change in 2017 Predicted NPP compared to 1982-2011 mean NPP (%)



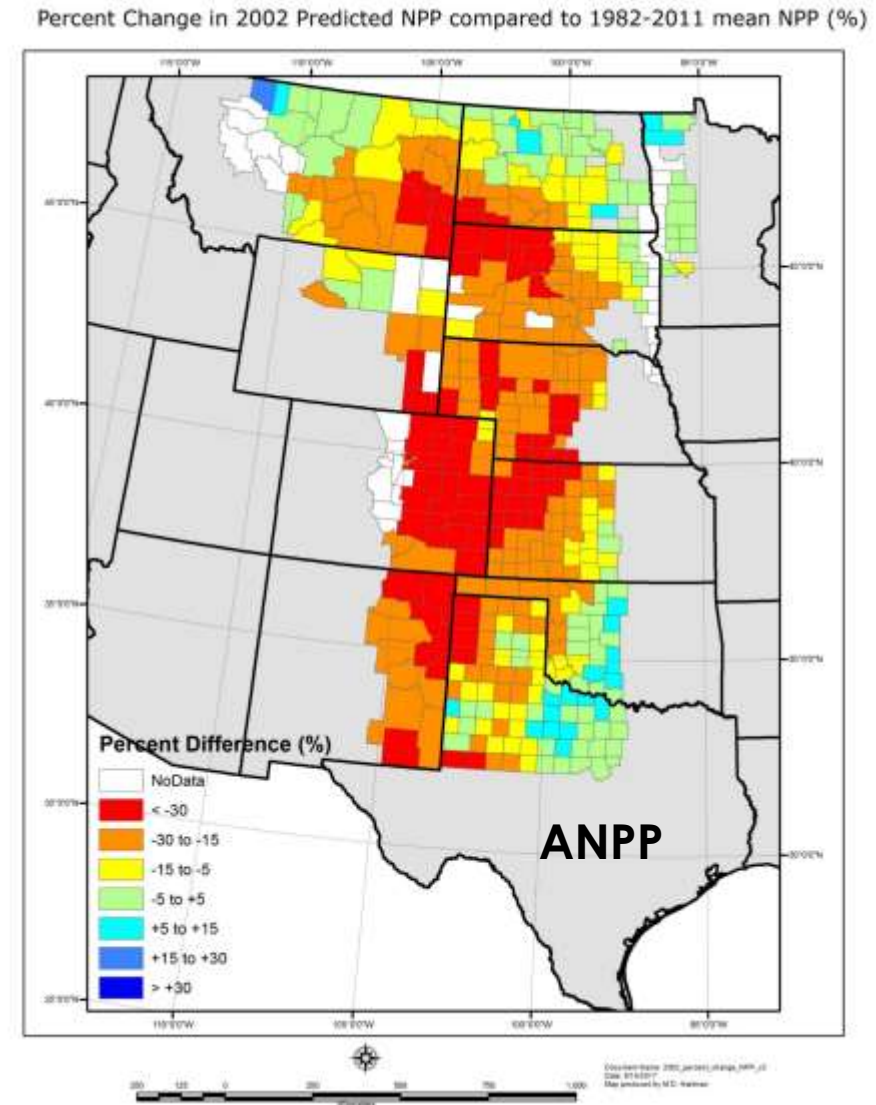
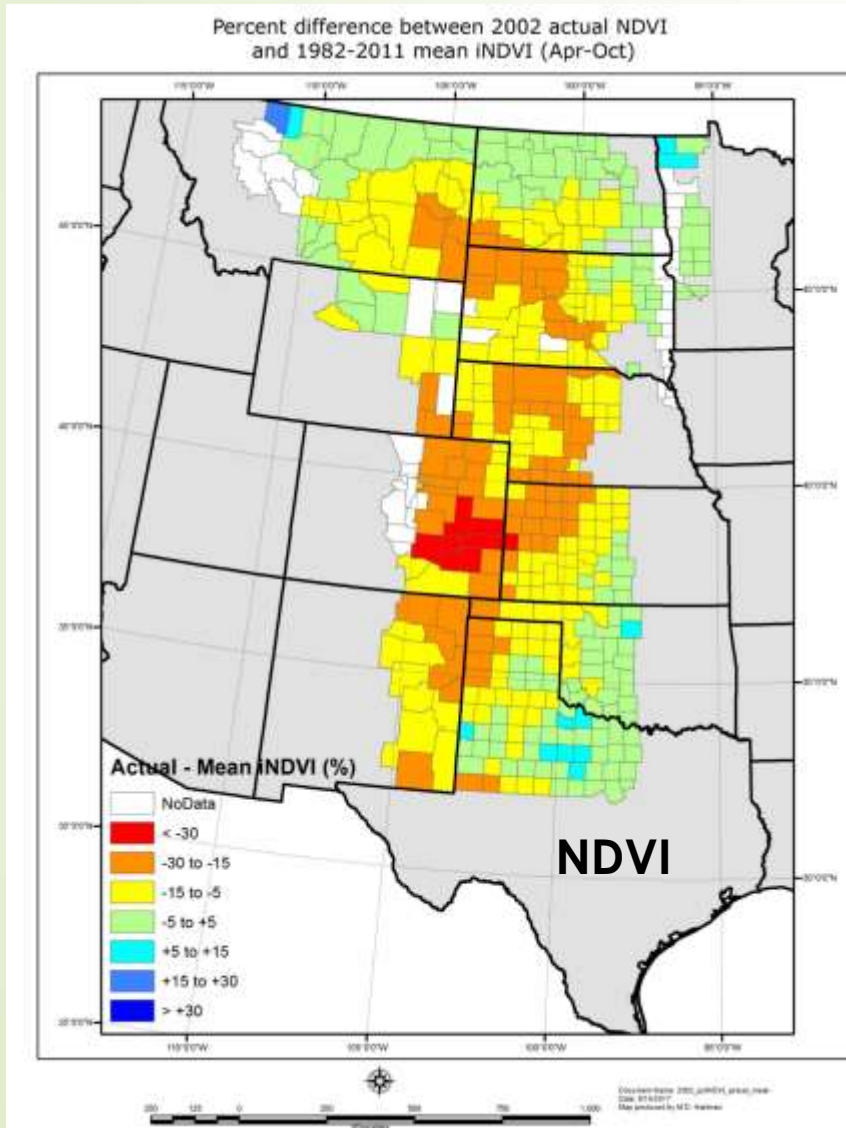
# ANPP Predictions improve with time

Difference between **July 31** predicted ANPP  
and 1982-2011 mean NPP (lbs/acre/year)



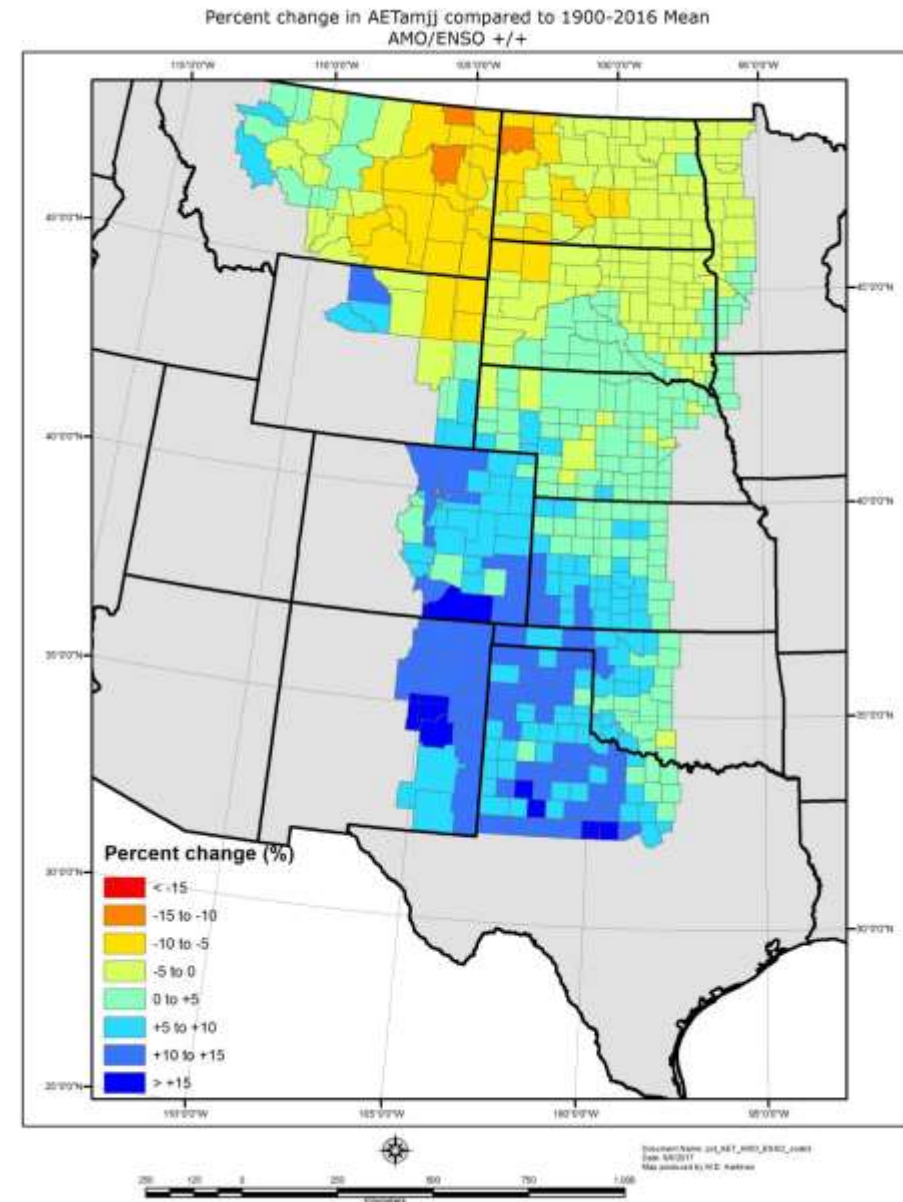
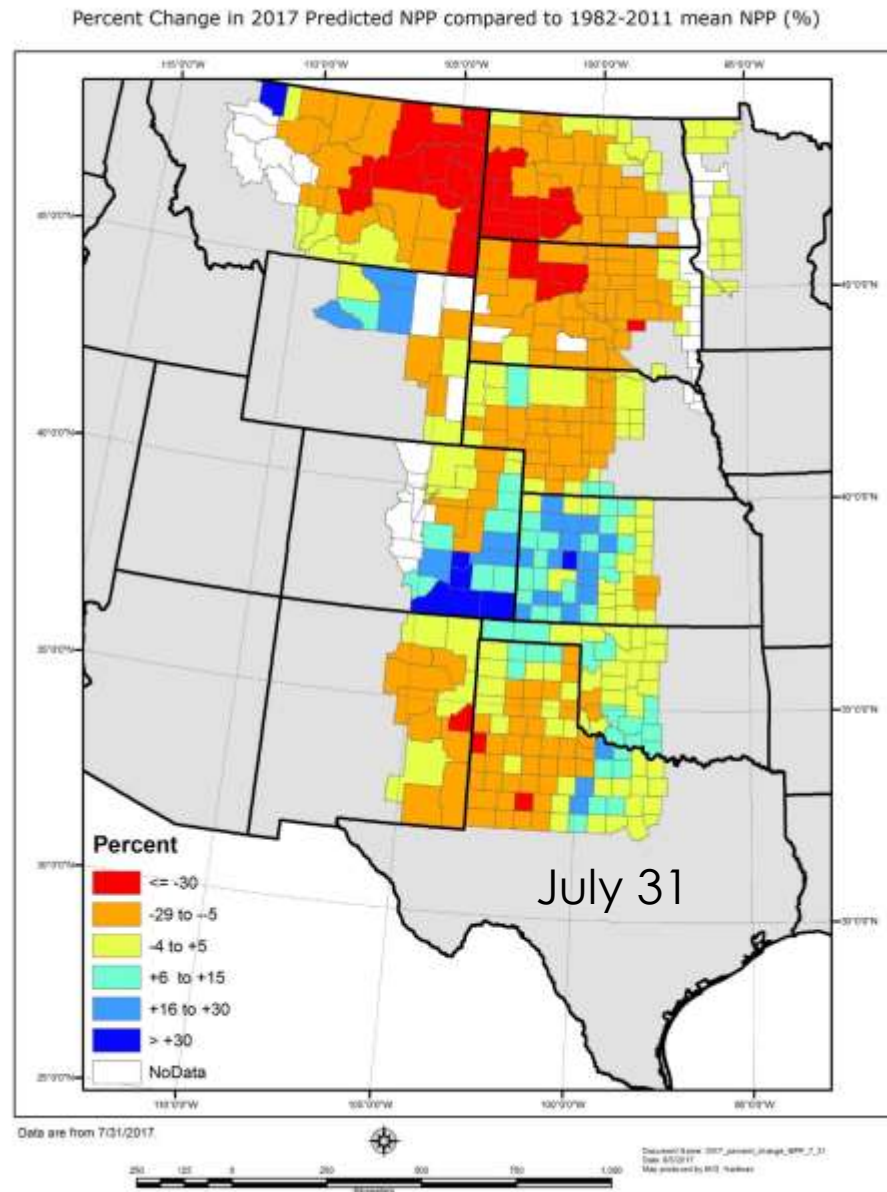
Difference between predicted ANPP and 1982-2011 mean ANPP for 3 dates (lbs/acre/year)

# 2002 (Dry Year) Actual NDVI compared to Predicted ANPP Percent change compared to 1982-2011 means



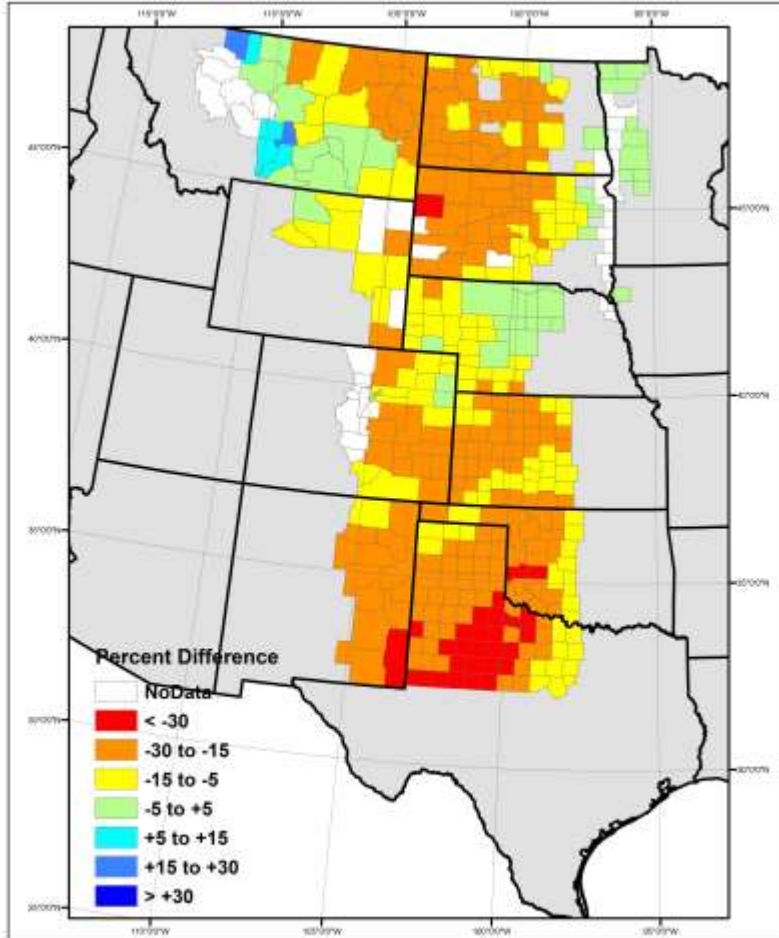


# Final ANPP Forecast compared to April 2017 SST anomaly



# GrassCast ANPP forecasts for April 22, 2018

Percent Change in 2018 Predicted NPP compared to 1982-2017 mean NPP  
Assuming Below Normal May-July Precipitation (%)

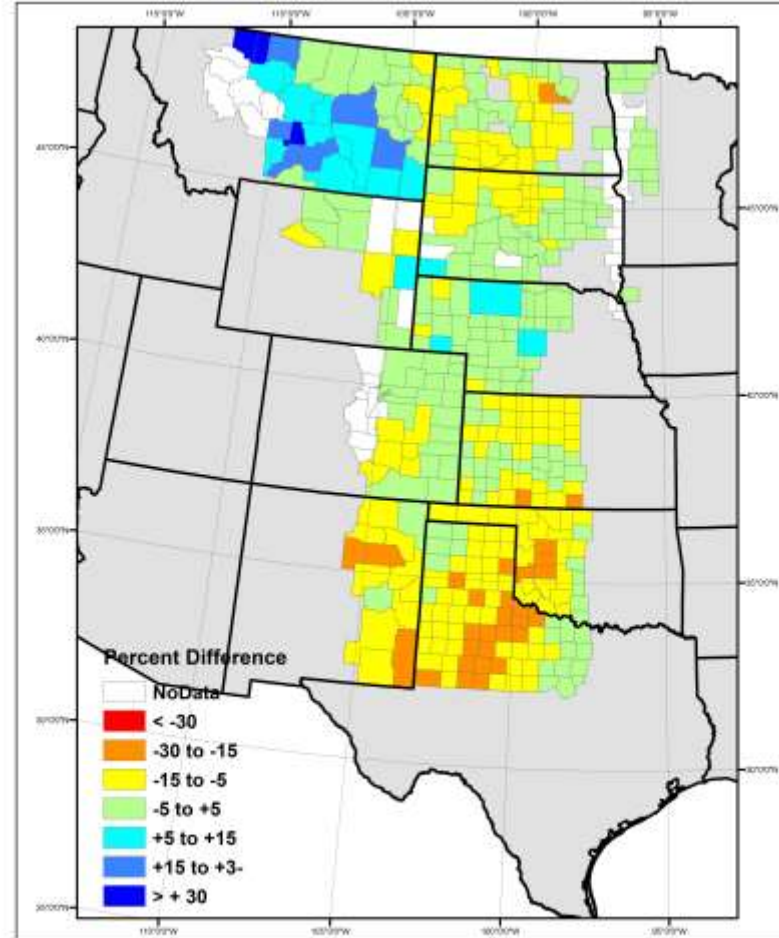


Data are from 4/22/2018



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2018\_percent\_change\_NPP\_A\_22\_below  
Date: 4/22/2018  
Map produced by M.D. Harmon

Percent Change in 2018 Predicted NPP compared to 1982-2017 mean NPP  
Assuming Normal May-July Precipitation (%)

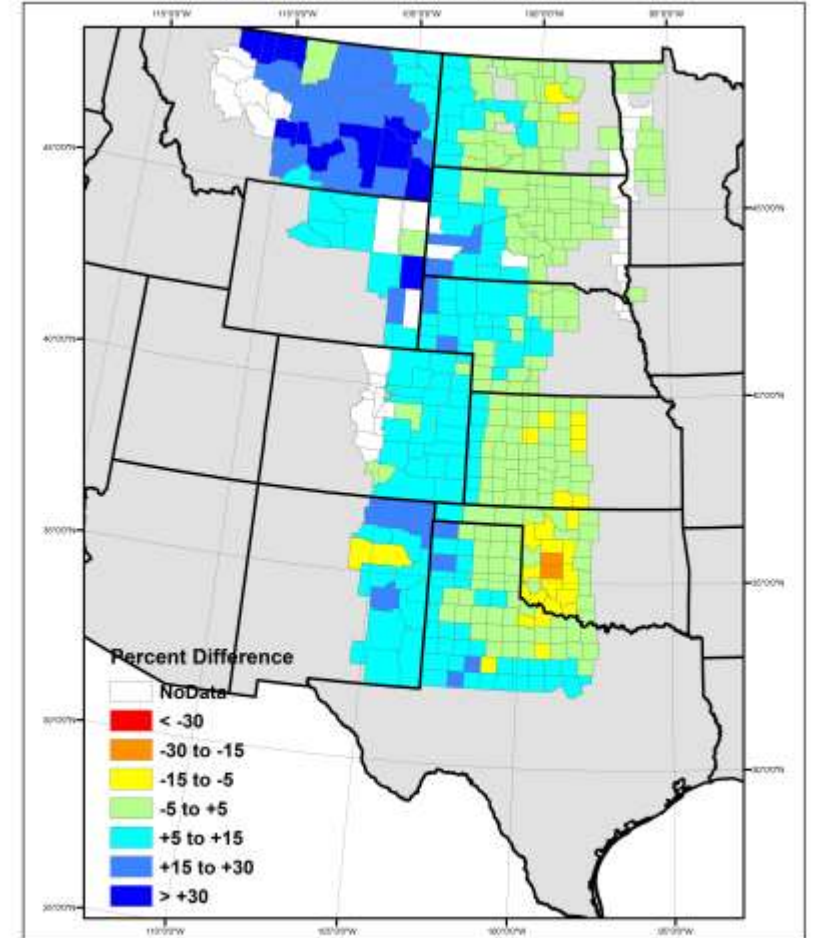


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Map produced by M.D. Harmon

Percent Change in 2018 Predicted NPP compared to 1982-2017 mean NPP  
Assuming Above Normal May-July Precipitation (%)



Data are from 4/22/2018



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Map produced by M.D. Harmon

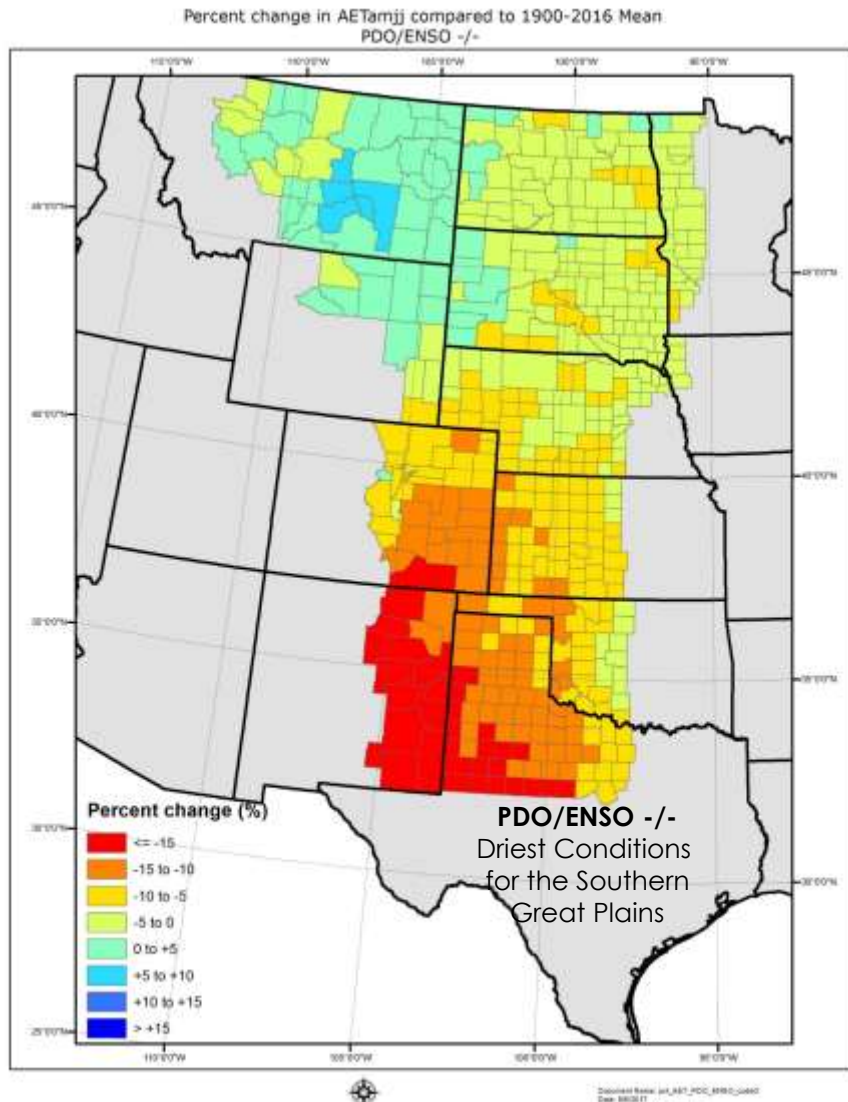
# Conclusions

- ANPP in the Great Plains is correlated to AMO, PDO and ENSO sea surface temperature anomalies
- Plant productivity is correlated to NDVI. Both NDVI and NPP are correlated to AET.
- Grass-Cast has the potential to predict regional patterns of ANPP for the Great Plains given the observed weather data and seasonal forecasts of precipitation
  - ANPP forecasts greatly improve after May 15
  - Grass-Cast forecast of ANPP are very similar to growing season observed NDVI data sets

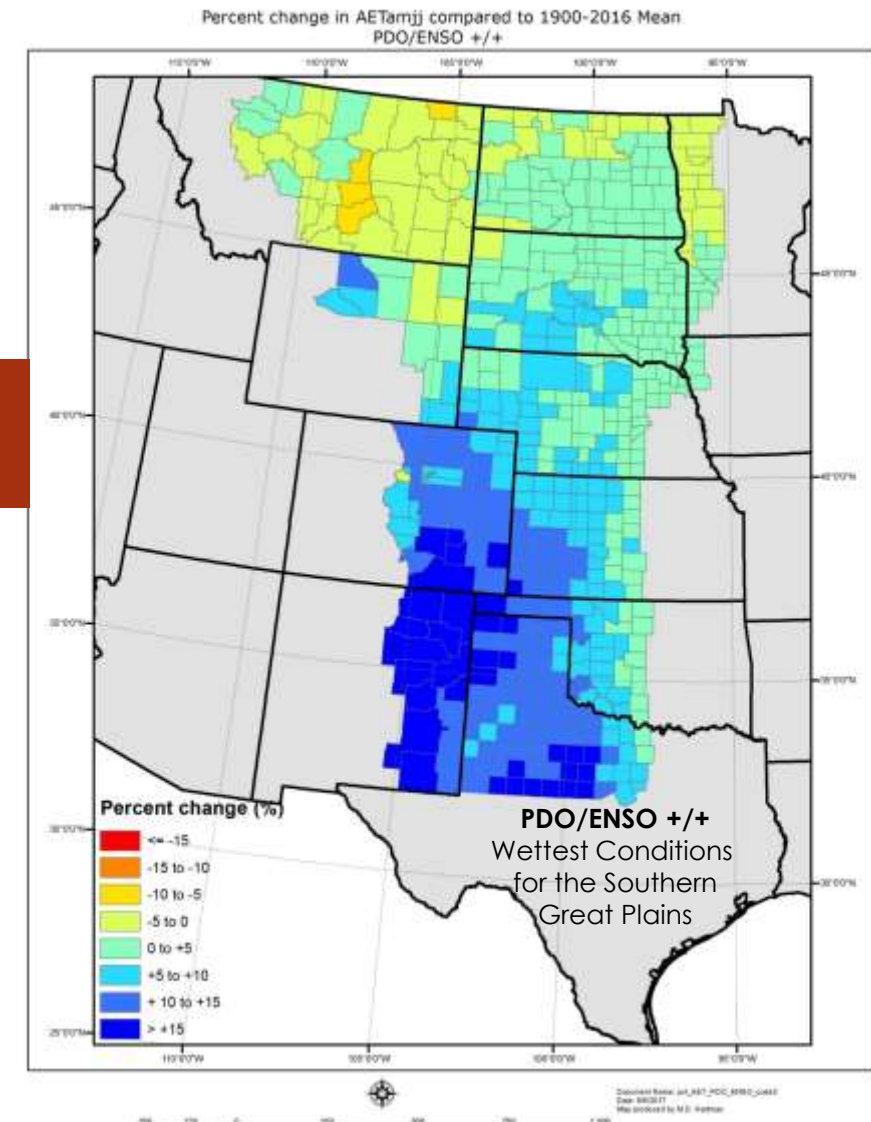


# Use of April Sea Surface Temperature (SST) anomalies to predict iAET for the Great Plains

## PDO and ENSO both negative



## PDO and ENSO both positive



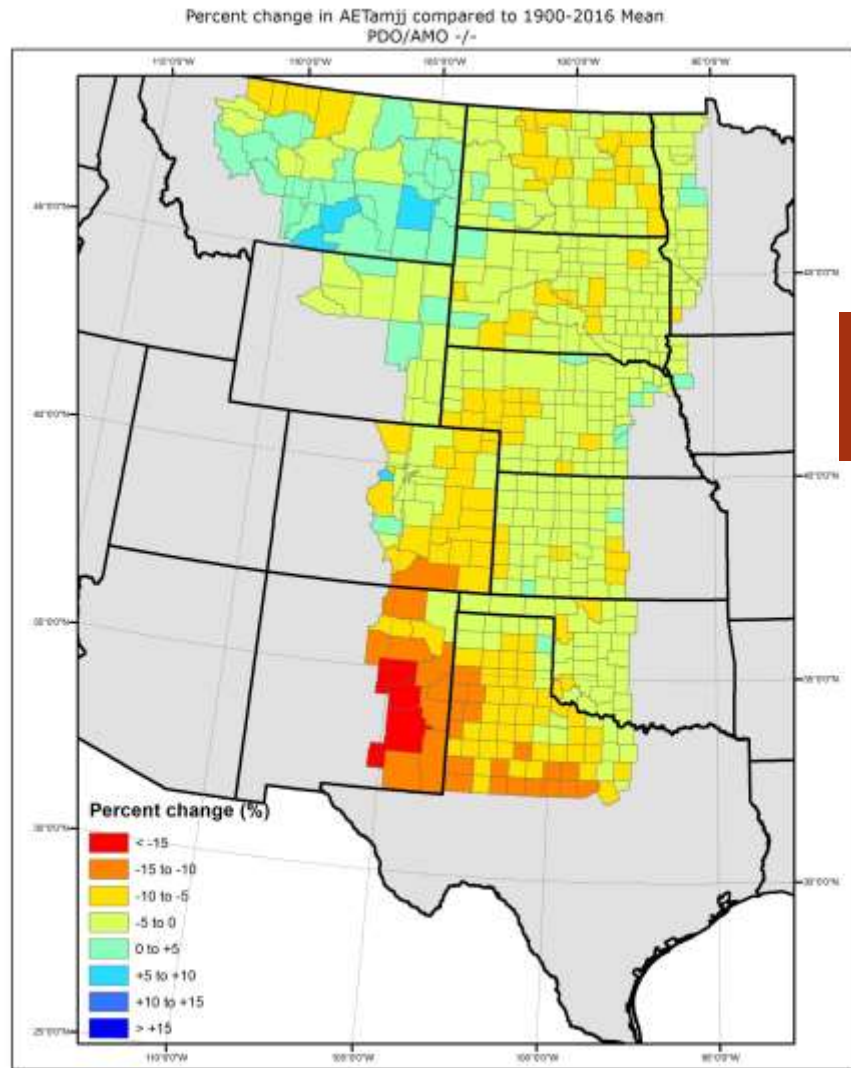
PDO/ENSO  
extremes

PDO = Pacific Decadal Oscillation

ENSO = El Niño Southern Oscillation

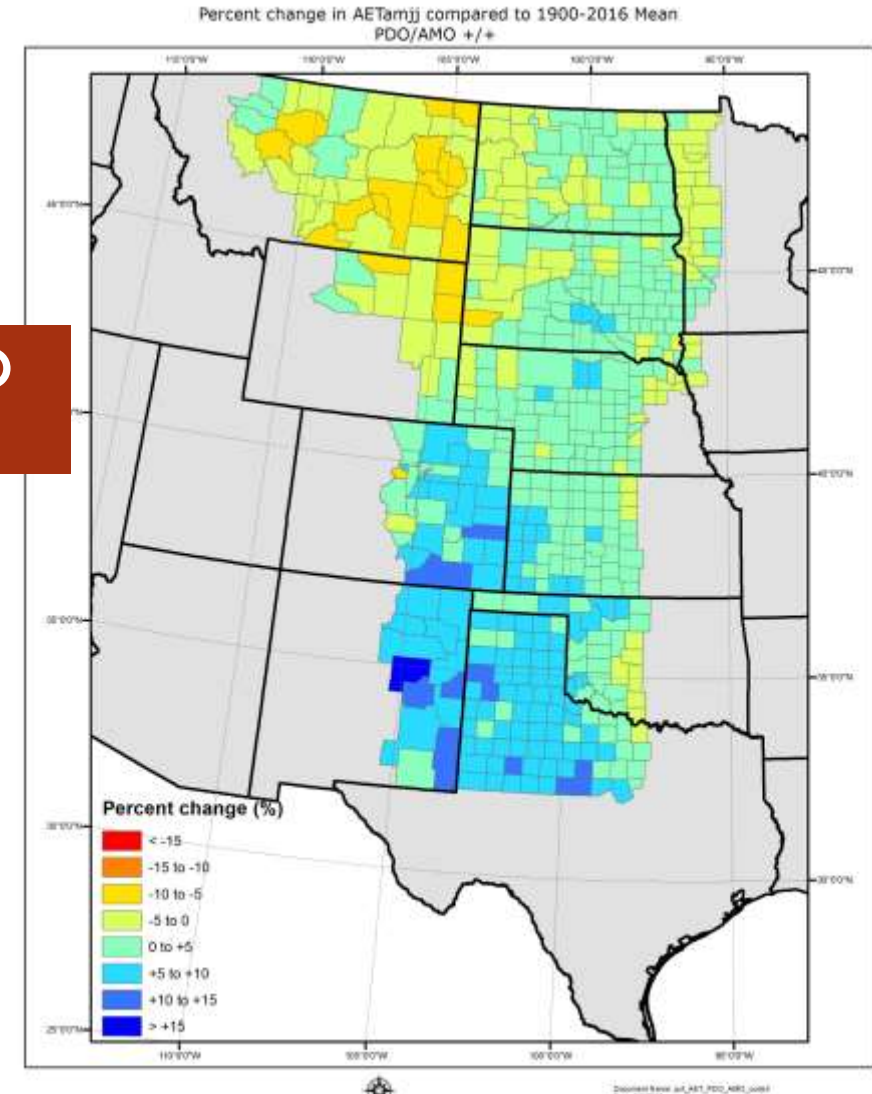
# Use of April Sea Surface Temperature (SST) anomalies to predict iAET for the Great Plains

PDO and AMO both negative



PDO = Pacific Decadal Oscillation

PDO and AMO both positive



PDO/AMO  
extremes

AMO = Atlantic Multidecadal Oscillation



Spring NDVI (May 4-12) correlates to growing season production  
(NDVI can be measured by drones as well as satellites)

